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# Spirorbinae (Polychaeta, Serpulidae) from Hokkaido I.<sup>1)</sup>

By

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(With 8 Text-figures and 9 Tables)

There was only one genus *Spirorbis* (Daudin, 1800) belonging to the subfamily Spirorbinae, and the genus was divided into several subgenera by Caurelly and Mesnil (1897). But Hartman (1959) elevated the subgenera to genera. The characters for identification of this group were the shape of setae in the thoracic segments, opercula, and tubes. But recently some species in European shores were investigated by Harris (1964, 1968a, 1968b), Gee (1962, 1964) and Knight-Jones (1962, 1967) in England and L'Hardy and Quiévreux (1962, 1963, 1964, 1965) in France. Resulted in these studies, the identifications of the species concern to check not only the kinds and numbers of the thoracic segments but also those of abdominal segments, and larval morphology. In 1964, Gee discussed the phylogeny of Spirorbinae together with the descriptions of the British species. In this paper, he proposed the phylogeny of Spirorbinae by the number of larval glands as a new category besides the characters of thoracic segments, and incubation styles.

Harris (1968a, b) proposed the differences of the shapes of setae between right and left side added as the important specific character. And now, we can identify only in the case of the many living individuals and embryos are obtained. Therefore, many species described in ancient time cannot be determined the genus and their systematic positions for their imperfect descriptions, since many species are remained in the old genus *Spirorbis*.

In Japan, six species of Spirorbinae were reported. *Dexiospira nipponica* Okuda, 1934 from northern Japan (Okuda 1934a, 1937, Annenkova 1937, Uschakov 1955), *D. spirillum* (Linnaeus 1758) from all around Japan (Okuda 1934a, b), *D. bellulus* (Bush 1904) from Suruga Bay in middle Japan (Moore and Bush 1904) and *D. foraminosa* (Bush 1904) from Izu in middle Japan and Matsushima Bay in northern Japan (Moore and Bush 1904, Okuda 1938, Okuda and Yamada 1954) in *Dexiospira*. *Leodora arguta* (Bush 1904), and *L. coronata* (Zachs 1933) from Hokkaido (Imajima and Hartman 1964) in *Leodora*. And the other one

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species from Suruga Bay was described by Bush (Moore and Bush 1904) as the name of *Spirorbis dorsatus* with only a dextrally empty tubes. Now the author describes four new species belonging to the genera *Paradexiospira*, *Deziospira* and *Laeospira*.

The author wishes to express his gratitude to Prof. Mayumi Yamada and Dr. Shôichi F. Sakagami for their kind advices promoting this study. He is also indebted to Prof. Y. Nakamura, Institute of Algological Research of Hokkaido University, Muroran, and Prof. Y. Kanoh of Akkeshi Marine Biological Station, Akkeshi for their kind procedures to this study at their laboratories.

### Descriptions of the Species

#### Genus *Paradexiospira* Caullery and Mesnil 1897

Spirorbinae dextral with four setigerous thoracic segments, the fourth segment has not any setae nor uncini on right (opercular) side. The tube is vitreously translucent. The winged setae in first thoracic setigerous segment are always much dentate. In the third setigerous thoracic segment, setae are characteristic sickles and the striped part is much reduced. The incubation of embryos in the tube. No larval glands.

There are four species and now I propose one new species.

*P. cancellata* (Fabricius 1780)

*P. vitrea* (Fabricius 1780)

*P. violacea* (Levinsen 1884)

*P. falklandica* (Pixell 1913)

*P. nakamurai* sp. nov.

#### *Paradexiospira nakamurai* sp. nov.

(Figs. 1, 2. Tables 3, 4)

*Tube* dextrally coiled, translucent, with three longitudinal ridges, among them middle one strongest. The form of tube variably changes depending on the condition of the substratum. Low and broad one (Fig. 1, A) in the case of loose distribution on the substratum, but high and narrow one in crowd (Fig. 1, B-C).

*Branchiae* of six filaments in two bundles, slightly orange in colour, with four or five branches on each side.

*Operculum* being same as tentacles in colour, with a cuticular opercular plate as a shallow dish possessing elliptical thick part in the central and weak developed proximal extension as the talon (Fig. 1, D-G), and with short opercular stalk of the stable shape in side view in living state as shown in Fig. 1, F. The rim very smooth and with some dust same as the surface of the operculum. The young specimen (diameter of tube 300  $\mu$ ) have the short talon, having a low extension of its side (Fig. 1, H).

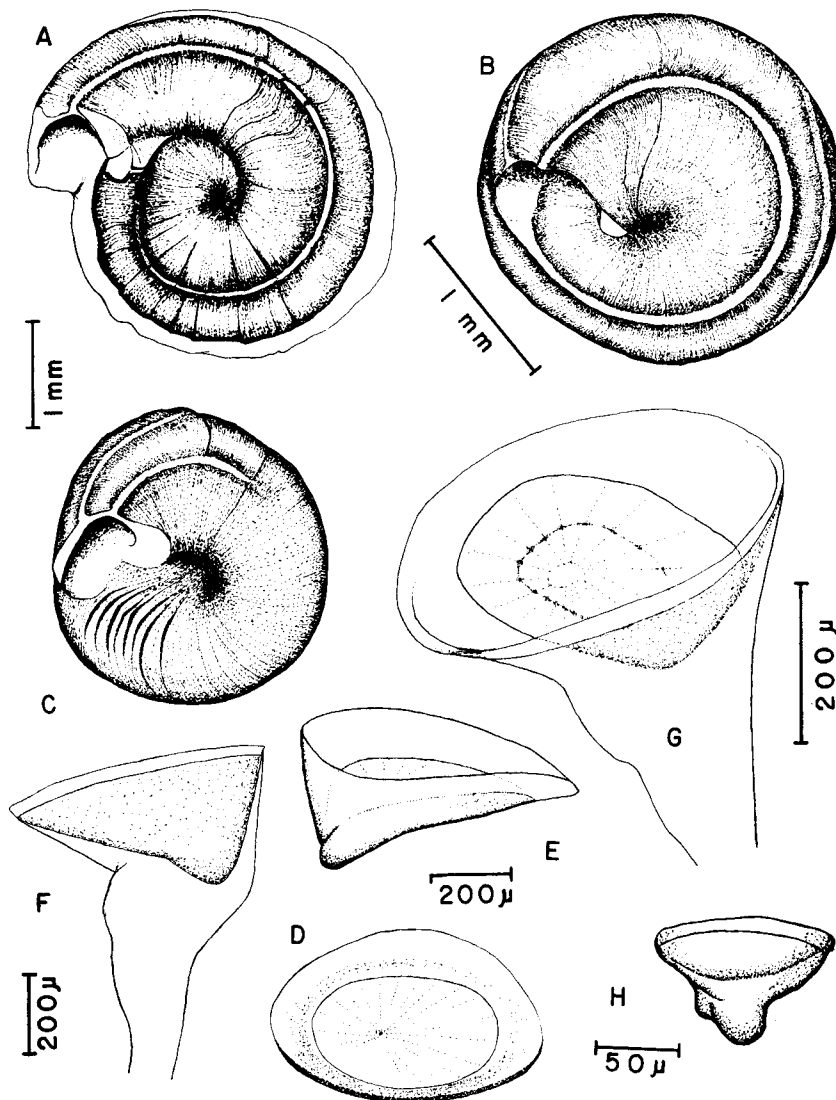


Fig. 1. *Paradexiospira nakamurai* sp. nov. A. Loosely coiled tube in rough distribution; B-C. Condense crowded tubes in crowded distribution; D. Calcareous plate in operculum (upper view); E. The same (lateral view); F. Operculum (lateral view); G. The same (front view); H. Calcareous plate in operculum of very young specimen (diameter of the tube: 300  $\mu$ ) with characteristic talon.

Thoracic setae and uncini are shown in Fig. 2, and Tables 3 and 4.

*Collar setae* are of two kinds, ones are winged limbate setae with weak cross-striations (Fig. 2, A-B), and the others are smooth capillary setae (Fig. 2, C). There are no differences on shapes between right (opercular side) and left setae.

*Second thoracic setae* are of two kinds, bordered setae and capillary setae. Bordered setae are simple (Fig. 2, D), and capillary setae are the same shape as collar setae (Fig. 2, E).

*Third thoracic setae* are of two kinds, sickle shaped and capillary setae. The serrated part of sickle shaped setae 1/3 long of limbate part, and serrated part very peculiarly projects toward non-serrated side (Fig. 2, F-G). There is a narrow neck between serrated part and simple limbate part. The capillary setae have the same shape of that in collar and second thoracic segment. There are not bordered setae in the third thoracic segment.

*Thoracic uncini* sub-rectangular with many small teeth in 6-7 longitudinal rows on the free edge terminating anteriorly in a peg-like tooth (gouge) being not so large and not projecting out as *P. vitrea*. Anterior edge jutting out to the front underside, so the uncini are seen as having the accessories on the top in upper view (Fig. 2, I-K). Length of the uncini in both sides of each segment are shown in Table 1.

Abdomen separated from thorax by fairly long aseptigerous region. Setigerous part consists of about 40 segments. The number of setae and uncini on each side being unequal in the same segment. The colour of the gonads orange, and other parts colourless or slightly pale orange. Abdominal setae and uncini are shown in Fig. 2, L-N.

*Abdominal setae* geniculate with serrations on free edge and a row of teeth immediately above the shaft (Fig. 2, L).

*Abdominal uncini* almost same form of thoracic uncini, but more thick in upper view (Fig. 2, N), and nearly triangular in side view (Fig. 2, M). The position of the tours with maximum number of uncini is around the 5th setigerous segment on right side and very variable on left side.

*Setation* (Table 3, 4): The collar setae consist of ten winged limbate and ten capillary setae on left side and eight of both kinds of setae on right side. The components of the collar setae are almost stable. Second and third thoracic setae are variable in number. The comparison of the thoracic setation with the other three species of which the thoracic setation are known in the genus *Paradexiospira* (*P. vitrea*, *P. violacea*, and *P. cancellata*), shows that this species has many setae especially in the first segment and each 10-14 capillary and sickle shaped setae on both sides of third segment, on the other hand, other three species have 9 and 5 components on the same segments. Abdominal segments of this species peculiarly much (about 40 segments) (*P. cancellata* 25-30, *P. violacea* about 20, *P. falklandica* about 20, *P. vitrea* until 31 segments). The setation of the abdominal uncini shows the striking bilateral asymmetry as in *P. vitrea* (Cresp et al. 1967) in the anterior region. The segments without uncini are very long in

the left side.

*Incubation* in the tube, two or three rows of eggs. Ovum orange in colour and  $170\mu \times 120\mu$  just before hatching.

*Larvae* orange in colour and approximately  $250\mu$  long and  $100\mu$  wide and  $100\mu$  high in the broadest thoracic part in just hatched stage, and having no larval glands (primary shell glands), with two pairs of eyes, the posterior pair of them large and renal shaped.

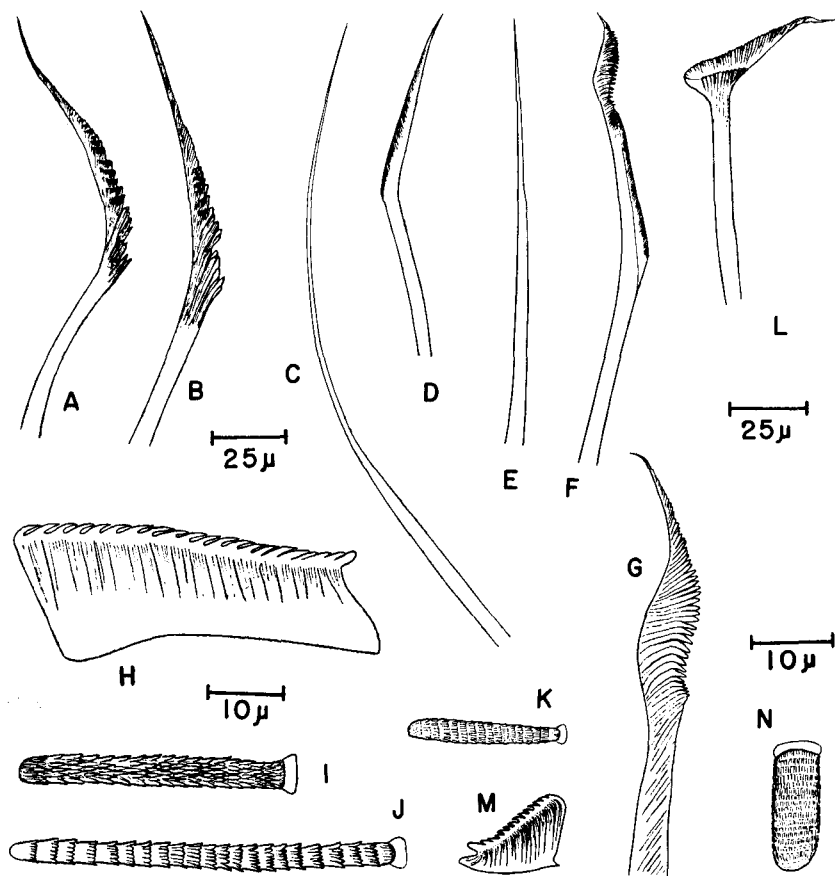


Fig. 2. *Paradexiospira nakamurai* sp. nov. A. Right collar winged seta; B. Left collar winged seta; C. Left collar capillary seta; D. Right second thoracic bordered seta; E. Right second thoracic capillary seta; F. Left third thoracic sickle seta; G. Anterior part of right third thoracic sickle seta; H. Right second thoracic uncinus (lateral view); I. Right second thoracic uncinus (upper view); J. Right third thoracic uncinus (upper view); K. Left second thoracic uncinus (upper view); L. Left 4th abdominal seta; M. Right 6th abdominal uncinus (lateral view); N. Third abdominal uncinus.

*Habitat*: Settled on the rock with somewhat rough surface together with the other Serpulids, Spirorbids and some coralline algae from lower tidal line to the sea bed of 10 m depth in rocky shores.

*Breeding season*: March to July.

*Locality*: Muroran, Oshoro, Akkeshi.

#### Remarks

The species name *nakamurai* refers to Professor Y. Nakamura, the director of the Institute of Algological Research, Muroran where the author collected the species first.

This species differs from *P. falklandica* (in Hartman 1966) in the number of tentacular filaments, this species six, and *P. falklandica* ten.

This species differs from *P. violacea* (in Caurelly and Mesnil 1897, and Bergan 1953) in the structure of winged collar setae, of which this species have fins on the bases of serrations, but without these structure in *P. violacea*.

This species closely resembles *P. vitrea*, but differs from *P. vitrea* in the following characters. (*P. vitrea*: Caurelly and Mesnil 1897, Borg 1917, Wesenberg-Lund 1952, Bergan 1953, Gee 1964, and Crisp, Bailey and Knight-Jones 1967)

*Operculum*; opercular stalk not so long as *P. vitrea*, and stable in shape in side view. The shape of the talon of young specimen differs from *P. vitrea* (in Caurelly and Mesnil 1897) very much. Calcareous plate with the elliptical thick part in the central part. With proximal extension being more or less developed on the base of calcareous plate.

*Collar setae*; with weak cross-striations.

*Third thoracic setae*; distal serrated part widened remarkably toward the non-serrated side. Narrow neck being in contact with the serrated part. A third of limbated part being serrated, while a half in *P. vitrea*. Limbated part 90  $\mu$  long in this species but 20–50  $\mu$  in *P. vitrea*.

*Abdomen*; abdominal segments about 20 (Borg 1917, and Gee 1964) or at most 31 (Bergan 1953) in *P. vitrea*, but in this species about 40.

Abe (1943) reported on ecological observation of Spirorbids from Asamushi (northern part of Japan). "*Spirorbis* sp. 2" (p. 329) in his paper seems to be this species.

#### Key to species in the genus *Paradexiospira*.

- |   |  |                                |
|---|--|--------------------------------|
| 1 | Thoracic segments 3 1/2 .....  | <i>P. cancellata</i>           |
| 1 | Thoracic segments 3 1/4 .....  | 2                              |
| 2 | Winged collar setae without fins on their bases of serration .....                       | <i>P. violacea</i>             |
| 2 | Winged collar setae with fins on their bases of serration .....                          | 3                              |
| 3 | With finely serrated setae only in collar fascicle .....                                 | <i>P. falklandica</i>          |
| 3 | With smooth capillary and serrated setae in collar fascicle .....                        | 4                              |
| 4 | Non-serrated side of serrated part of third thoracic sickel shaped setae projected ..... | <i>P. nakamurai</i> spec. nov. |

- 4 Non-serrated side of serrated part of third thoracic sickle shaped setae not projected ..... *P. vitrea*

### Genus *Dexiospira* Caurelly and Mesnil 1897

Spirorbinae dextral with three setigerous thoracic segments, the first segment with no uncini on both sides. The tube chalky white with or without longitudinal ridges or transverse lines. Incubation of embryos in the tube or in operculum. There are 25 described species.

#### *Dexiospira oshoroensis* sp. nov.

(Figs. 3, 4, Tables 1, 5, 6)

*Tube* dextrally coiled, chalky white, thin with weak transverse growth lines as *D. spirillum* and with or sometimes without three weak longitudinal ridges near the opening. According to the substratum (the column of the brown algae), sometimes the tube irregularly bended along the column of substratum (Fig. 3, A). Tube small in size, and maximum about 1 mm in diameter. Frequently numerous small diatoms attached on the tube so that the tube with brown stains.

*Branchiae* colourless, and seven in number, each with eight to nine pairs of branches.

*Operculum* colourless, and its shapes changeable in the case of the mass of eggs (Fig. 3, C-F). The opercular plate crown-form and its shapes changeable too. In the case of empty operculum, the plate is low and weak developed proximal extension as the talon (Fig. 3, C), but brood operculum has the high calcareous plate without biased extension (Fig. 3, F). Opercular stalk long.

*Thorax* three segments, with no eye-spots in adult. Thoracic setae and uncini are shown in Fig. 4, and Tables 5 and 6.

*Collar setae* are of two kinds, ones are winged setae, and the others are capillary setae with the narrow limbate part on its distal part (Fig. 4, D-E). The winged setae with no differentiation into fin and blade, similar to the collar setae in *D. spirillum*, and different in size and degree of dentation. The winged setae in left side are large and much dentate on the most part of free edges and the teeth of them long, but that in right side are small (length of free edges of these are 2/3 of that) (Fig. 4, A, C).

*Second thoracic setae* are of two kinds, bordered setae and capillary setae. Bordered setae may be finely striated and weakly dentate, and different in size between left and right sides (Fig. 4, F-G). Capillary setae in both sides the same structure of those of collar capillary setae on right side (Fig. 4, H).

*Third thoracic setae* are of two kinds, bordered setae and capillary setae. Bordered setae (Fig. 4, I-J) are the same as that of the second segment. The left one more or less larger than the right. Capillary setae (Fig. 4, K) simple.

*Thoracic uncini* sub-rectangular with many teeth in 4 or 5 longitudinal rows (Fig. 4, M-N). The dentate edge curved inside on side view (Fig. 4, L). On the



distal edge of dentation, there is a large triangular projection (gouge) and small teeth on its back of both sides in upper view (Fig. 4, O). There are no differences between right and left sides, and between the second and third thoracic segments not only about the structure but also about the size.

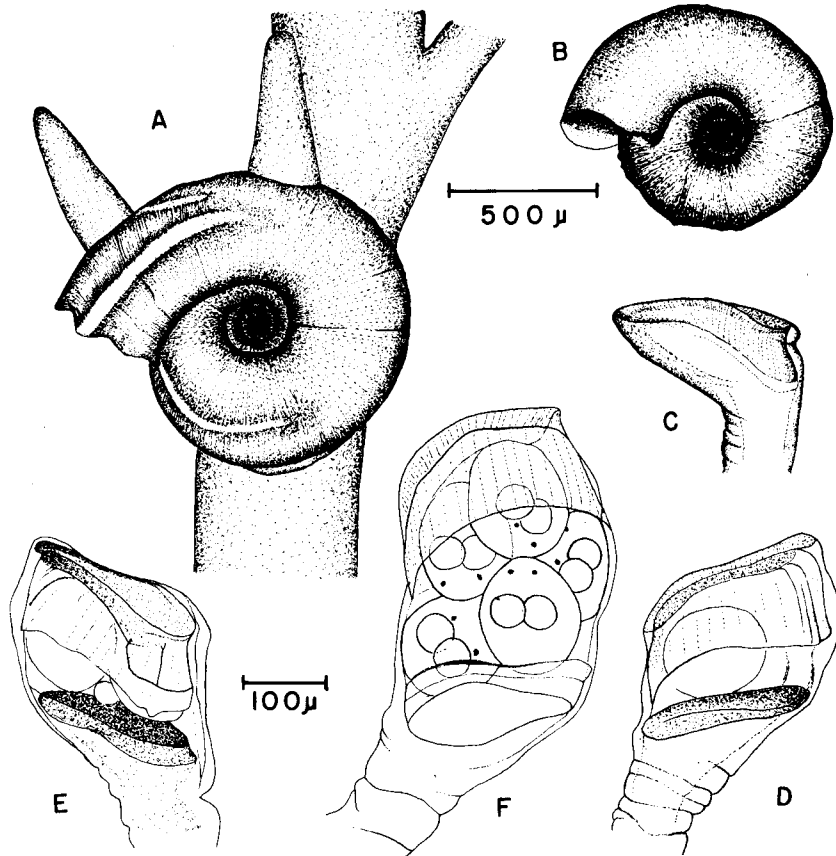


Fig. 3. *Dexiospira oshoroensis* sp. nov. A. Tube attached on the brown alga *Sargassum thunbergii*; B. Tube of younger specimen; C. Operculum of juvenile specimen; D-F. Opercula with embryos.

Abdomen consists of about 12 (10–13) setigerous segments, and orange in colour. Hepatic pigment brown. The numbers of setae and uncini on each segment are shown in Table 5 and 6. The asetigerous region between the thoracic and abdominal setigerous segments is very wide and equal of setigerous part in length.

*Abdominal setae* geniculate with blades falciform and serrated blades (Fig. 4, P).

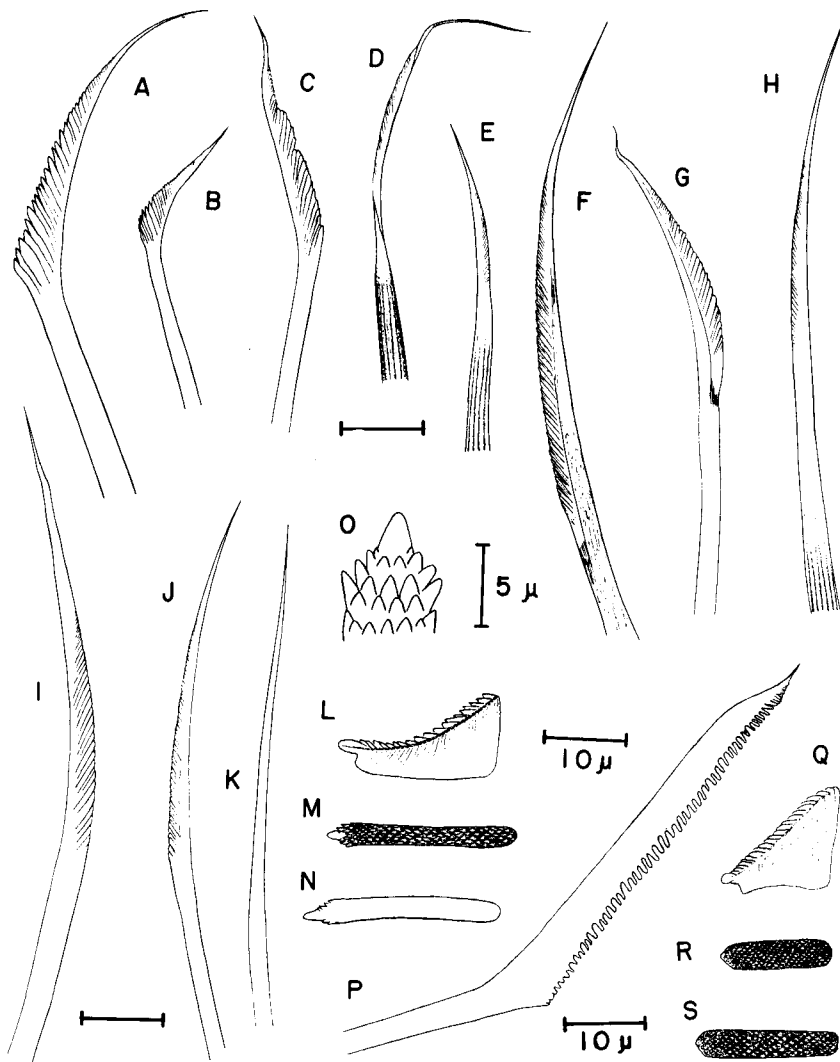


Fig. 4. *Dexiospria oshoroensis* sp. nov. A. Left collar winged seta; B. Undeveloped winged seta from the same segment; C. Right collar winged seta; D. Left collar capillary seta; E. Right collar capillary seta; F. Left second thoracic seta; G. Right second thoracic bordered seta; H. Left second thoracic capillary seta; I. Left third thoracic bordered seta; J. Right third thoracic bordered seta; K. Left third thoracic capillary seta; L. Thoracic uncinus (lateral view); M. Right third thoracic uncinus (upper view); N. Right second thoracic uncinus (upper view); O. Distal part of the same; P. Abdominal seta; Q. Left side abdominal uncinus (lateral view); R. Left side abdominal uncinus (upper view); S. Right side abdominal uncinus. (Figures except for O are in the same scale.)

*Abdominal uncini* sub-triangular and the terminal large tooth projected towards on side view, and thicker than those on the thoracic segments, but shorter than them.

*Setation* (Table 5, and 6): Collar setae consist of six winged and six capillary setae on both sides in the most specimens. The second setae consist of 6–8 capillary setae and 9–13 bordered setae on both sides. The thoracic setae show symmetry. The thoracic uncini are almost the same in number in both sides of third segment, and right side of second segment (24–36), and the uncini on only the left side of second segment is few in number (13–21). Each abdominal segment has almost only one geniculate seta on each side. The position of the torus with maximum number of uncini is 4th setigerous segment on right and 3rd segment on left side. This tendency is clearly observed in this species. The setation of this species is similar to that of *Dexiospira corrugata* (Montagu 1808) in Harris (1968a), but it is quite different from *D. corrugata* in that there are two kinds of setae on the second and third thoracic segments on the other hand there are only one kind of setae on all the second and third segments in this species.

*Incubation* in the operculum. Eggs in the operculum are greenish gray in colour and  $160\mu$  in diameter, and become  $140\mu \times 120\mu \times 120\mu$  when just before hatching and change to be almost colourless except for the eyes and larval glands.

*Larvae* just hatched are  $200\mu \times 100\mu \times 100\mu$  and almost colourless but two pairs of red eyes and one pair of white larval glands (primary shell glands) having the ball-shape of  $50\mu$  in diameter.

*Habitat*: Settled on the brown alga *Sargassum thunbergii* (Mertens) in the middle tidal zone in rocky shore. Breeding season April to October.

*Locality*: Oshoro.

#### Remarks

*Dexiospira* involves about 20 species except for unidentifiable species of incomplete descriptions.

This species is separated from eight species, *D. spirillum* (Linnaeus 1758), *D. armoricana* (Saint-Joseph 1894), *D. marioni* Caurelly and Mesnil 1897, *D. semidentata* (Bush 1904), *D. alveolata* (Zachs 1933), *D. bushi* (Rioja 1942), *D. tricornigerus* (Rioja 1942), and *D. glossoeides* (Harris 1968) having the tube incubation style.

This species is also separated from three species, namely *D. pagenstechei* (Quatrefages 1865), *D. pusilloides* (Saint-Joseph 1894), and *D. incongruus* (Bush 1904) by the structures of collar setae. These three species have the collar setae with fins.

We can distinguish this species from *D. unicornis* (Bailey and Harris 1968) which have the sickle shaped limbate third thoracic setae.

We have still 10 species having opercular incubation and similar aspects. This species is separated from *D. lamelosa* (Lamarck 1818), *D. rugata* (Bush 1904), *D. ceylonica* Pillai 1960, and *D. treadwelli* Pillai 1965 by the structure of collar setae. These four species have broad collar setae with large teeth on their free

edges.

*D. oshoroensis* n. sp. differs from *D. corrugata* (Langerhans 1880)<sup>1)</sup> by several characters, but most important difference is that *D. corrugata* with cross-striation on the collar setae of non-opercular side.

This species differs from *D. nipponica* (Okuda 1934) in the both thoracic and abdominal uncini, tentacles number, opercular plate, and the surface of the tube. *D. nipponica* with the trifurcated thoracic and abdominal uncini, and with six filaments in radiole. *D. nipponica* has the opercular plate with long cylindrical calcareous part touching to the next plate. *D. nipponica* has the remarkable three longitudinal ridges and deeply engraved mouth opening of the tube.

*D. oshoroensis* n. sp. differs from *D. foraminosa* (Bush 1904)<sup>2)</sup> in the structure of tube and operculum, and collar setae. *D. foraminosa* has the remarkable three longitudinal ridges and many foramina between these ridges on its tube. Operculum of *D. foraminosa* cylindrical with peduncle. The thoracic setae of *D. foraminosa* all simple tapered blades, and in collar segment tapered and almost smooth free edged setae only.

*D. oshoroensis* n. sp. differs from *D. formosa* (Bush 1904) in the structures of operculum and collar setae. The operculum of *D. formosa* with thin filmed collar-like rim around the calcareous plate, and the hand-shaped peculiar talon. The collar setae are simple tapered blades same as *D. foraminosa*.

This species differs from *D. karaitivensis* Pillai 1965 in several factors. The operculum of *D. karaitivensis* with a pair of triangular calcareous plates on the dorsal side and a wavy rim at the top. Collar setae are more slender than that of *D. oshoroensis*. Thoracic uncini rectangular and with small gouge.

Remaining one species *D. compta* (Bush 1904) was given imperfect description and *D. oshoroensis* is not clearly distinguished from this species, but can be distinguished by the tube of *D. compta* which possesses the central cavity.

1) *D. corrugata* not Montagu 1808. See Gee 1964, p. 425.

2) *D. foraminosa* originally described by Bush in Moore and Bush (1904). She pointed out the specific characters of this species as the foraminated tube and cylindrical operculum with peduncle, and in this paper we can only find three figures about operculum and collar seta which were drawn very simply. Since 1904, Okuda 1938 and Okuda and Yamada 1954 described this species with the simplest notes. Okuda (1947) wrote this species in the Illustrated Encyclopedia of Fauna of Japan. He proposed the figure of whole body with branchiae of 8 radioles. Imajima and Hartman (1964) described this species but almost the same as that of Bush (1904). In the New Illustrated Encyclopedia of the Fauna of Japan (1965), Imajima described that *D. foraminosa* has 8 radioles.

But recently Day described this species from South Africa (Day 1957, 1961, 1967). The original description was very imperfect and there are few differences among the Japanese and African species. In Day (1961), "No actual foramina were observed." "The branchiae have 7 radioles with long naked tips." And we can't find the peduncle in the operculum in the Day's descriptions or figures. Now we must examine the two kinds of *D. foraminosa* whether the same species or not.

***Dexiospira ainu* sp. nov.**

(Figs. 5, 6. Tables 1, 7, 8)

*Tube* dextrally coiled, chalky white, thin, with two or three longitudinal discontinuity ridges as the teeth, and with many irregular transverse growth lines (Fig. 5, A-B). The opening almost round. 1.0–2.5 mm in diameter.

*Branchiae* pale orange in colour or colourless and seven in number, each with seven to eight pairs of branches, and with long terminal region of filaments.

*Operculum* almost colourless, cylindrical form with fin-like limb around the top and broad calcareous cylinder (a half of whole operculum in length) with a bend on its ventral side (Fig. 5, C-D). Opercular stalk very short. In non-breeding season, the operculum flattened and makes the flat calcareous plate with broad and low talon (Fig. 5, E-H).

*Thorax* three setigerous segments with one pair of orange eyespots. Pale orange in colour only in the collar and colourless in other part. Thoracic setae and uncini are shown in Fig. 6, and Tables 7 and 8.

*Collar setae* are of two kinds, ones are winged setae, and the others are capillary setae with fine dentation through the free edges (Fig. 6, C-D). The winged setae with serration through the free edges, and distal part serrated largely, but with no proximal fins. The winged setae different on both sides, broader blades and cross-striations on left (non-opercular) side, and narrower blades and without cross-striations on right (opercular) side, and serration larger in the left winged setae (Fig. 6, A-B).

*Second thoracic setae* are of two kinds, bordered setae and capillary setae. Bordered setae with long blades having finely striation and no differences on both side (Fig. 6, E-F). Capillary setae gradually reduced in width and with the finest striations throughout their one side, but these striations not so deep (about 1/4 of the width of capillary setae), and these striations were barely observed by the use of a  $\times 100$  objective phase contrast lens (Fig. 6, G-H).

*Third thoracic setae* are of two kinds, bordered setae and capillary setae. Bordered setae same structure as the second bordered setae, but not so long on bordered part, and no differences on both sides (Fig. 6, I-J). Capillary setae same as the second ones (Fig. 6, K-L).

*Thoracic uncini* sub-rectangular with many teeth in 6 longitudinal rows. Gouge triangular and not so high and with 2–3 teeth on both sides of it, the gouge part thicker than the other parts in upper view (Fig. 6, M-O).

Abdomen consists of about 11 setigerous segments, and almost colourless. Hepatic pigment grayish green. The numbers of setae and uncini on each segment are shown in Tables 7 and 8. The asetigerous region between thoracic and abdominal setigerous segments broad, and occupies 1/2 part of abdomen in length.

*Abdominal setae* geniculate with blades falciform and serrated blades (Fig. 6,

P). The setae in posterior segments short (Fig. 6, Q).

*Abdominal uncini* sub-triangular with many fine teeth on many longitudinal rows, and with gouges. The thickness of abdominal uncini equal that of thoracic ones (Fig. 6, R-T).

*Setation* (Tables 7 and 8): Collar setae consist of six winged and six capillary setae on both side in most specimens. The second thoracic setae consist of nine bordered and eight capillary setae. The third thoracic setae consist of six capillary and eight bordered setae on right and ten on left side. There are clear symmetrical setation in the thoracic setae except only for the case of bordered setae of third thoracic segment. The third thoracic segment with most uncini

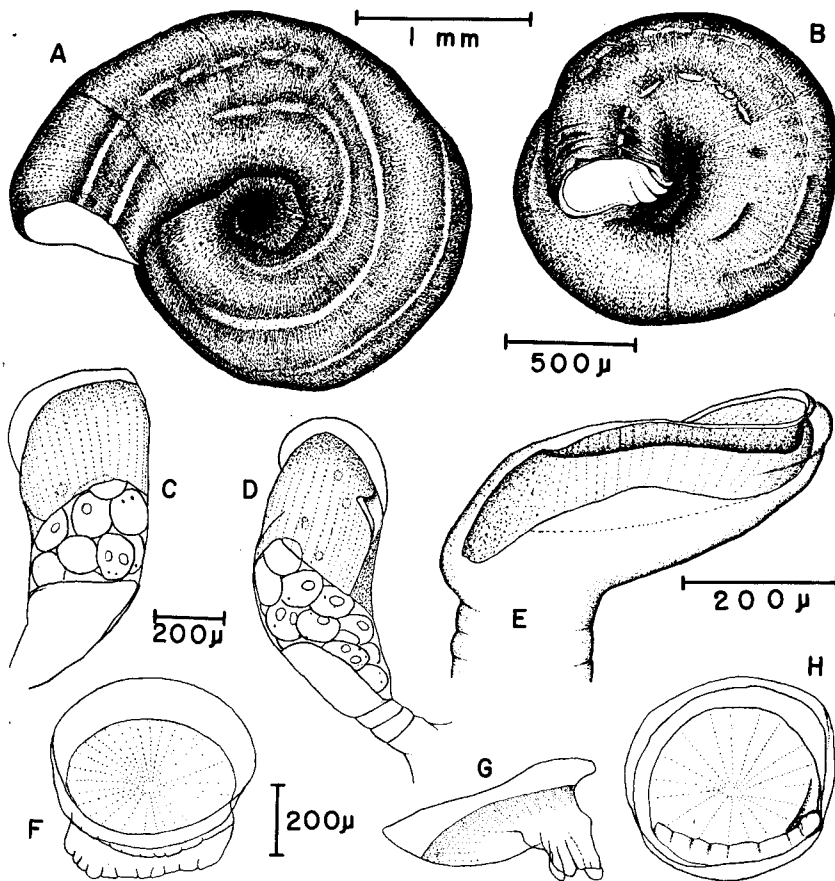


Fig. 5. *Dexiospria ainu* sp. nov. A. Well developed tube; B. Juvenile tube; C-D. Opercula with embryos; E. Operculum of juvenile specimen; F-H Calcareous plates in opercula (F: Upper side, G: Back side, H: Lateral side).

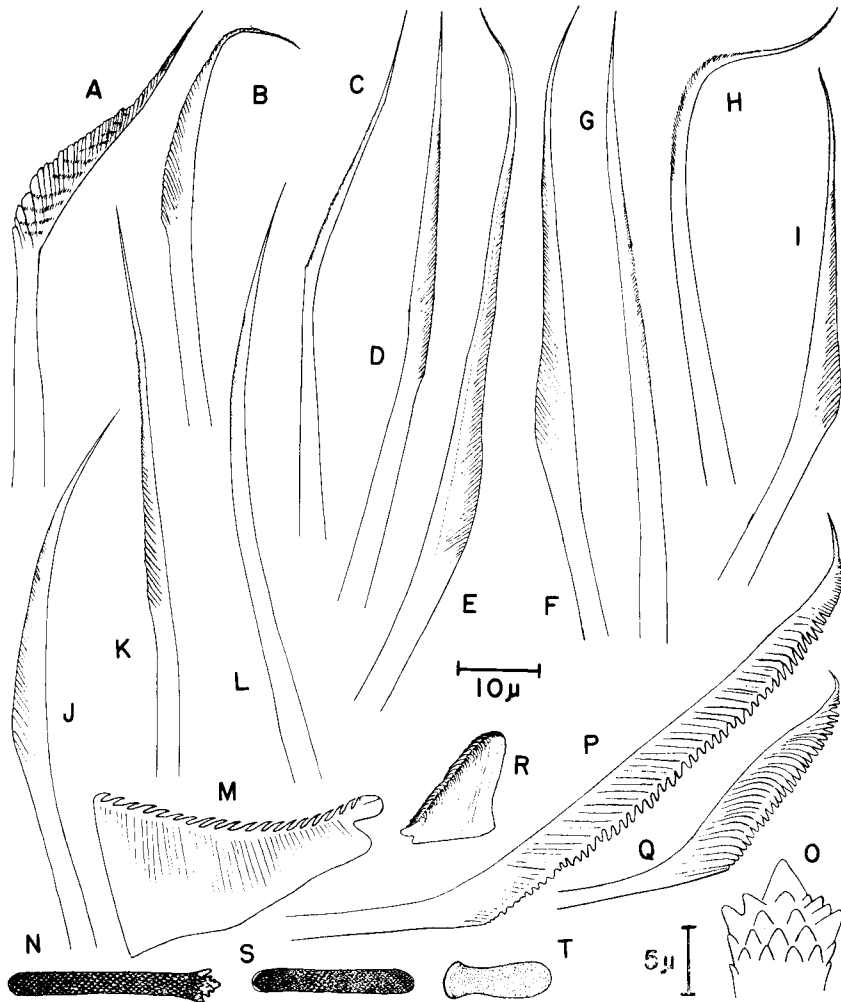


Fig. 6. *Dexiospira ainu* sp. nov. A. Left collar winged seta; B. Right collar winged seta; C. Left collar capillary seta; D. Right collar capillary seta; E. Left second thoracic bordered seta; F. Right second thoracic bordered seta; G. Left second thoracic seta; H. Right second thoracic capillary seta; I. Left third thoracic bordered seta; J. Right third thoracic bordered seta; K. Left third thoracic capillary seta; L. Right third thoracic capillary seta; M. Left second thoracic uncinus; N. Right third thoracic uncinus (upper view); O. Distal part of the uncinus from left third thoracic segment; P. Abdominal geniculate seta from right third segment; Q. Abdominal undeveloped geniculate seta from the last segment but two; R. Abdominal uncinus in anterior segment; S. The same (upper view); T. Abdominal uncinus in posterior segment. (Figures except for O are in the same scale.)

Table 1. Several characters of opercular

Species	Tube	Ten- tacle	Operculum	Collar Setae
<i>ainu</i> n. sp.	D=1-2.5 mm, two discontinued lon- gitudinal ridges.	7	Trumpet, short rectangular talon.	Cross-striation on the left winged setae, no fin.
<i>ceylonica</i> Pillai 1960	D=1 mm, three longitudinal ridges.	7	Cylindrical, collar-like rim.	Large rounded teeth on the left winged setae.
<i>corrugata</i> (Montagu 1808)	D=1 mm, 1-3 longitudinal ridges.	?	Narrow talon.	Cross-striation on the left winged setae.
<i>foraminosa</i> (Bush 1904)	D=1.5 mm, three longitudinal ridges.	8	Cylindrical, no talon.	All the narrow
<i>formosa</i> (Bush 1904)	Small, 2-3 longitudinal ridge.	?	Cylindrical, hand-shaped talon.	All the narrow
<i>karaitivensis</i> Pillai 1960	D=1 mm, one longitudinal ridge.	?	Cup-shaped, wavy edged to the lid.	Finely
<i>lamellosa</i> (Lamark 1818)	D=1.31-1.88 mm three longitud- inal ridges.	7	Cylindrical, shrot talon.	8 large traingular teeth on the base of left winged setae.
<i>nipponica</i> Okuda 1934	D=1.5-2.3 mm, three longitudinal ridges.	6	Cylindrical, no talon.	All the narrow
<i>oshoroensis</i> n. sp.	D<1 mm, three weak longitudinal ridges.	7	Cylindrical, no talon.	Generally dentate, different in size on both sides.
<i>pagenstecheri</i> (Quaterfages 1865)	D=1-1.5 mm, three remarkable longitudinal ridges.	7	Trumpept, stick-like talon.	Blade and neighboring fin in winged setae.
<i>pusilloides</i> (S.-Joseph 1894)	D=1 mm.	7	Trumpet.	Blade and neighboring fin in winged setae.
<i>rugata</i> (Bush 1904)	Weak longitudinal ridges, and grouth lines.	7	Cylindrical, short rectan- gular talon.	Very broad scalloped, tapered blades.



incubating species of the genus *Dexiospira*.

Second setae	Third setae	Thoracic uncini	Abdominal		Larval glands	Substratum
			setae	uncini		
Limbate and capillary.		5 gouges, 27-37 $\mu$ .	Falciform, 7 $\times$ 70 $\mu$ .	20 $\mu$	2	Rock.
Geniculate and minutely serrated.		Single row of teeth, 15 $\mu$ .	Geniculate and denticulate, 2.5 $\times$ 17 $\mu$ .	?	?	Oyster shell.
Limbate.		One gouge, 34 $\mu$ .	Falciform, 5 $\times$ 60 $\mu$ .	9 $\mu$	2	<i>Zostera marina</i> <i>Ulva</i> sp. <i>Caulerpa</i> sp.
tapered blades.		3-5 gouges, 5 rows of teeth.	Falciform.	?	?	Algae.
tapered blades.		?	Triangular, fine serrated.	?	?	<i>Sargassum</i> sp.
serrated.		One large gouge, rectangular, 20 $\mu$ .	Geniculate, 3 $\times$ 22 $\mu$ .	?	?	<i>Halophila ovata</i>
Limbate.		?	?	?	2	Rock.
tapered blades.		3 gouges, 30 $\mu$ .	Falciform, 8 $\times$ 57 $\mu$ .	20 $\mu$	2	<i>Sargassum</i> sp. <i>Laminaria</i> sp.
Limbate and capillary.		One large gouge, 23 $\mu$ .	Falciform, 5 $\times$ 54 $\mu$ .	13-17 $\mu$	2	<i>Sargassum thunbergii</i>
?	Sickled setae.	2 rows of teeth, one gouge, 24-29 $\mu$ .	Geniculate, with a row of fin-like teeth.	?	?	<i>Laminaria</i> sp.
?	Sickled setae.	2 rows of teeth, one gouge.	Geniculate.	?	?	?
Very narrow.		?	?	?	?	Rock.

Table 1.

Species	Tube	Ten- tacle	Operculum	Collor Setae
<i>treadwelli</i> Pillai 1965	D=0.8 mm, three remarkable longi- tudinal ridges.	7	Cylindrical, no talon.	8 large triagnular teeth on the base of left winged setae.
<i>unicornis</i> (Bailey & Harris 1968)	D=1-1.5 mm, 3 longitudinal ridges.	?	Cylindrical, plate with a papilla.	Simple blade winged setae and capillary setae.

on right side, and the number of uncini in right side of the second and left side of third are almost equal. The second left side with least uncini same as the case of *D. oshoroensis* n. sp. Each abdominal segment except for the first segment has one or two geniculate setae. The position of the torus with maximum number of uncini is the first segment on right side and the second segment on left side. The setation of this species similar to that of *D. pagenstecheri* Quatrefages 1865 (in Gee 1964), *D. corrugata* (Montagu 1808) (in Harris 1968a), and *D. oshoroensis* n. sp. But *D. pagenstecheri* with different numbers of winged and capillary setae on both sides, and the position of torus with maximum number of uncini is the second segment on both sides. These two species namely *D. ainu* n. sp. and *D. pagenstecheri* have the strong symmetrical tendency about the setation in thorax and abdomen.

*D. oshoroensis* has several torus without uncini on right side abdomen, and has no tendency of maximum number of uncini on first or second abdominal segment. *D. corrugata* has several torus without abdominal setae on left side.

*Incubation* in the operculum. Embryos grayish green and developed orange with red eyespots and a pair of white larval glands. Embryos before just hatching  $150\mu \times 130\mu \times 130\mu$ .

*Larvae* pale orange or almost colourless with two pairs of reddish orange eyespots and one pair of white larval glands. Larvae just hatched  $260\mu \times 110\mu \times 110\mu$ . Larval glands almost rounded of  $50\mu$  in diameter.

*Habitat*: On the rocks and stones in the middle tidal zone in rocky shore (occasionally this species found on the empty shells of *Mytilus* or *Crenomytilus*).

*Locality*: Muroran.

#### Remarks

This species is also same as *D. oshoroensis* n. sp. separated from eight tube incubation species. This species has the collar setae with cross-striation and separated from all of opercular incubation species belonged to the genus *Dexiospira*, except for only one species namely *D. corrugata* (Montagu 1808). This species closely resembles to *D. corrugata* about the structure of tube, thoracic setae and abdominal setae and operculum, but differs from *D. corrugata* in the following characters.

Continued

Second setae	Third setae	Thoracic uncini	Abdominal		Larval glands	Substratum
			setae	uncini		
Slender serrated.		One gouge, 40-45 $\mu$ .	?	?	?	Rock.
Limbate.	Sickle.	5 rows of teeth, 26 $\mu$ .	Geniculate, 3-6.5 $\times$ 45 $\mu$ .	20 $\mu$	?	Rock.

The cross-striation of this species not so strong as *D. corrugata*, and there are not stick like talon as *D. corrugata*, and abdominal uncini of this species twice as long as that of *D. corrugata*. The substratum of this species is rock, but eel-grass, brown or green alga (*Zostera marina*, *Ulva* sp. and *Caulerpa* sp.) in the case of *D. corrugata*. The thoracic uncini with four rows of teeth in *D. corrugata* but in this species six rows of teeth.

Table 1 gives the characters of 14 opercular incubated species belonged to the genus *Dexiospira*.

Key to species in *Dexiospira* with opercular incubation.

- 1 Collar setae with fins or noches.....2
- 1 Collar setae without fins nor noches.....4
- 2 Fin and blade not contact in collar setae.....*D. incongruus*
- 2 Fin and blade contact in collar setae.....3
- 3 Hepatic pigment violet.....*D. pagenstecheri*
- 3 Hepatic pigment red.....*D. pusilloides*  
(By Gee (1964) *D. pusilloides*=*D. pagenstecheri* var. *incoloris*)
- 4 With third thoracic sickle-shaped setae.....*D. unicornis*
- 4 Without sickle-shaped setae.....5
- 5 Collar setae without cross-striation.....6
- 5 Collar setae with cross-striation.....15
- 6 Collar setae with large teeth.....7
- 6 Collar setae with small teeth.....10
- 7 Operculum without talon.....8
- 7 Operculum with talon.....9
- 8 Collar setae with low teeth.....*D. treadwelli*
- 8 Collar setae with high and round-head teeth.....*D. ceylonica*
- 9 Talon anchor shape.....*D. lamelosa*
- 9 Talon low triangular.....*D. rugata*
- 10 Collar setae smooth tapered blades only.....11
- 10 Collar setae serrated blades and capillaries.....12
- 11 Tube with many foramina.....*D. foraminosa*

- |    |  |                        |
|----|--|------------------------|
| 11 | Tube without foramina .....                                | <i>D. formosa</i>      |
| 12 | Tube with central cavity .....                             | <i>D. compta</i>       |
| 12 | Tube without central cavity .....                          | 13                     |
| 13 | Uncini trifurcate .....                                    | <i>D. nipponica</i>    |
| 13 | Uncini not trifurcate .....                                | 14                     |
| 14 | Operculum with a pair of triangular calcareous plate ..... | <i>D. karaitivenis</i> |
| 14 | Without such structure .....                               | <i>D. oshoroensis</i>  |
| 15 | Thoracic uncini with six rows of teeth .....               | <i>D. ainu</i>         |
| 15 | Thoracic uncini with four rows of teeth .....              | <i>D. corrugata</i>    |

### Genus *Laeospira* Caullery and Mesnil 1897

Spirorbinae with sinistral opaque white tube. Three thoracic setigerous segments. The serrated collar setae with proximal fin, and with or without cross-striation. Incubation in the tube or operculum.

#### *Laeospira pacifica* sp. nov.

(Figs. 7, 8, Tables 2, 9)

? *Spirorbis quadrangularis* Bush 1904, p. 241, Pl. 39, Fig. 37, Pl. 40, Figs. 10, 11, 21, 23, 26, 30, Pl. 42, Figs. 23-29, Pl. 43, Figs. 14, 15.

*Tube* sinistral, opaque yellowish white with or without three weak longitudinal ridges and with many remarkable transverse growth lines. There is a central cavity. The diameter about 2 mm (Fig. 7, A-B).

*Branchiae* of nine filaments, colourless, each with eight or nine pairs of branches, and with very short terminal abranched region.

*Operculum* colourless except for the pale orange upper side, trumpet-shaped when no eggs in the operculum (Fig. 7, C-E), but long conical form (Fig. 7, F-G) when there are many eggs. The form of calcareous plate of operculum stable in shape, in the case with or without eggs. The calcareous plate rounded and a few circle lines on it. The talon large and with one triangular rift and a groove continued to this rift (Fig. 7, H). Operculum with a short stalk.

*Thorax* three segments. There are no differentiations of setae on both sides (uncini differ in size between both sides). Thoracic setae and uncini are shown in Fig. 8, and Table 9.

*Collar setae* are of two kinds, ones are winged setae, and the others are capillary with narrow blades (Fig. 8, A). Winged setae with fine serrated blades and proximal fins same as the collar setae in most species belonging to the genus *Laeospira*. But there are no cross-striations in every collar setae, and fin near from blade (Fig. 8, B). There are no differentiations of winged setae on both sides.

*Second thoracic setae* are of two kinds, bordered setae and capillary setae. Bordered setae may be finely striated but the striation scarcely observed on the basal part of blade (Fig. 8, C-D).

*Third thoracic setae* are of three kinds, bordered setae, sickle shaped setae and capillary setae. Bordered setae and capillary setae same as the second segment

(Fig. 8, E-F). Sickie shaped setae geniculate with fine striation and great dentation (Fig. 8, G), and almost straight in dentated region not so as the sickie shaped setae in many other species.

*Thoracic uncini* sub-rectangular with five longitudinal rows of teeth. The gouge large and consists of two side teeth (Fig. 8, I-L). Left thoracic uncini very large and 87–100 $\mu$  in length in both second and third segments. But right thoracic uncini small (43–47  $\mu$ ).

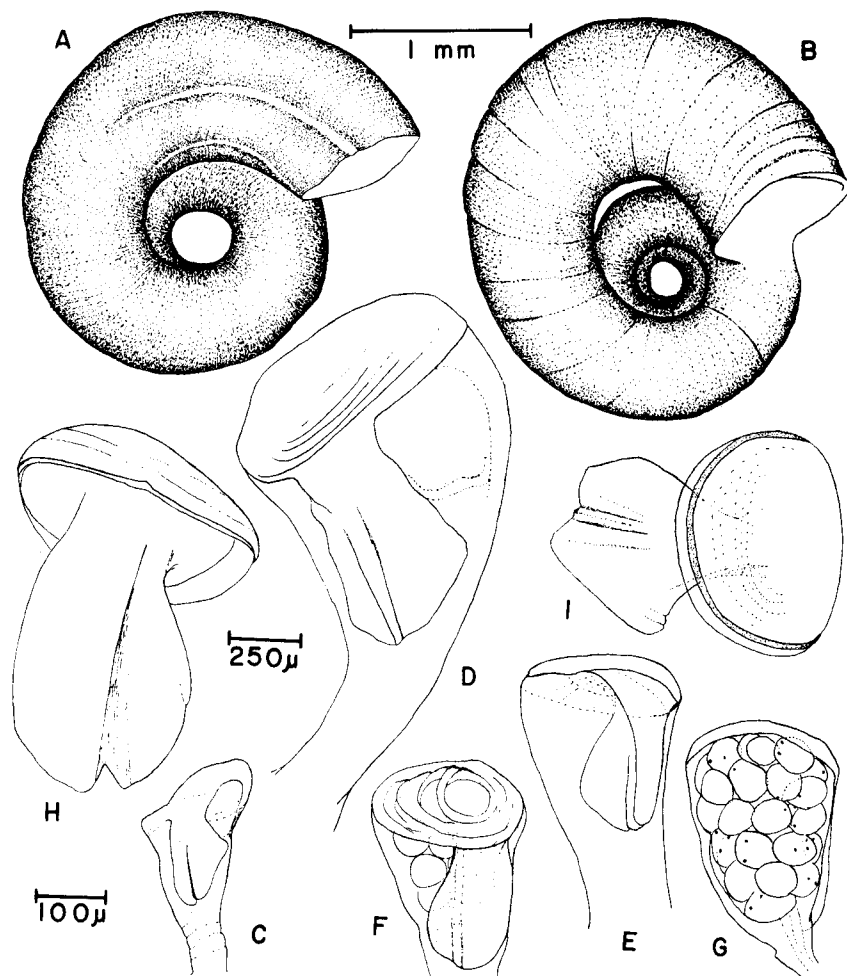


Fig. 7. *Laeospira pacifica* sp. nov. A. Tube with two longitudinal ridges; B. Tube with strong transversal growth lines; C-D. Opercula with no embryos; E. Operculum of juvenile specimen; F-G. Opercula with many embryos; H. Calcareous plate in operculum; I. Calcareous plate of the specimen being young a little.

Abdominal setigerous segments 20-26, and pale orange in colour. Hepatic pigment orange in colour. The numbers of setae and uncini on each segments are shown in Table 9. Asetigerous region between thorax and abdomen very narrow.

*Abdominal setae* of two kinds, ones geniculate (Fig. 8, M), and the others simple capillary (Fig. 8, N) generally tapered and with curved proximal part. Geniculate setae with many dentations on their free edges, and resemble to the collar setae of *Dexiospira spirillum*.

*Abdominal uncini* sub-triangular and thicker than thoracic ones and with fine dentations in 7-8 longitudinal rows on free edges (Fig. 8, O-P).

*Setation* (Table 9): The components of the thoracic setae are symmetrical in second and third segments, but in collar segment there are eight winged setae

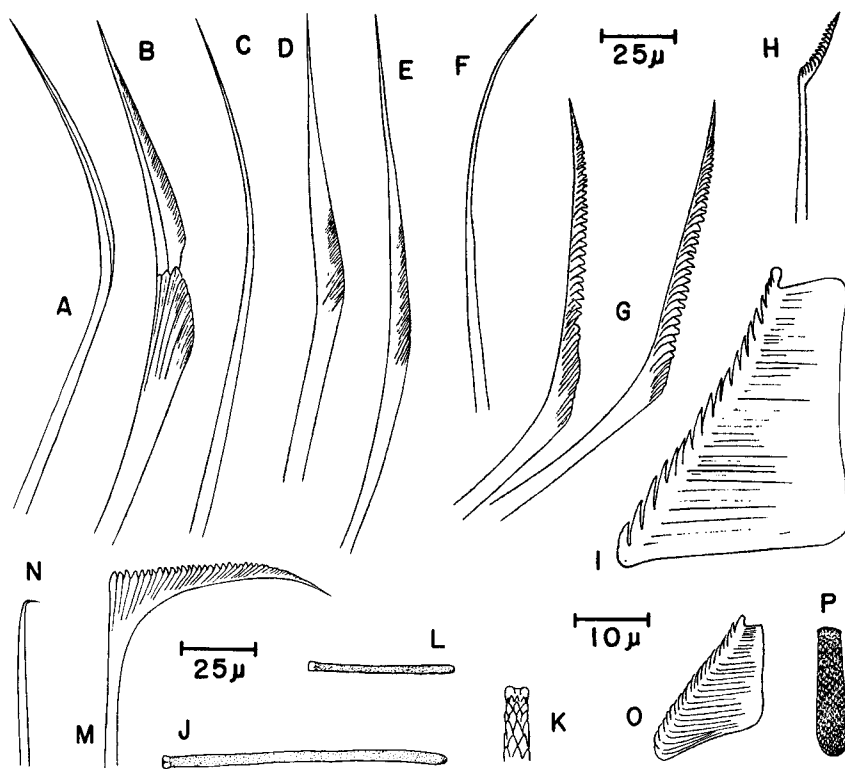


Fig. 8. *Laeospira pacifica* sp. nov. A. Left collar capillary seta; B. Left collar winged seta; C. Left second thoracic capillary seta; D. Left second bordered seta; E. Left third thoracic bordered seta; F. Left third thoracic capillary seta; G. Left third thoracic sickle seta; H. Undeveloped sickle seta in the same segment; I. Right second thoracic uncinus; J. Left second thoracic uncinus; K. Distal part of the same; L. Right third thoracic uncinus; M. Abdominal geniculate seta; N. Abdominal non-serrated seta; O-P. Abdominal uncini.

in right side and ten winged setae in left. The thoracic uncini arrange asymmetrically very much in both sides; there are about same in number in the left side of the second and third segments, and about 100–150 uncini. But there are less uncini in right side, and in the right second segment there are least uncini (about 30). There are 20–25 abdominal segments, and no setae in left side from the first to the third abdominal segments in most specimens, but in few specimens there is not the capillary setae only in the first segment. There are 1–3 geniculate setae in both sides of every segment, but in the last one or two segments, there are no geniculate setae. The segment where the number changing from two geniculate setae to one is 16th or 17th. The position of the torus with maximum number of uncini is around 5th segment in right side and third segment in left.

*Incubation* in the operculum. Eggs in the operculum brownish orange in colour with  $100\mu$  in diameter, and become  $130\text{--}150\mu \times 80\text{--}90\mu \times 80\text{--}90\mu$  when just before hatching, and change almost colourless except for the eyespots and larval gland.

*Larvae* pale orange in colour with one pair of large red eyespots, and with one semi-cubic larval gland having  $50\mu \times 40\mu \times 40\mu$  in mass.

*Habitat*: On the rocks or stones from the low tidal line in rocky shore.

*Locality*: Akkeshi.

#### Remarks

There are about 40 species in the genus *Laeospira*. These species are divided into two main groups by the incubation styles; one is tube incubating species and the other opercular incubating species. *L. pacifica* n. sp. belongs to the latter group. In this group, 18 species were already described.

*L. militalis* (Claparède 1870), *L. mörchi* (Levinsen 1884), *L. langerhansii* Caullery and Mesnil 1897, *L. papillata* Pixell 1913, *L. berkeleyana* Rioja 1942, *L. helenpixelli* Rioja 1942, *L. pseudomilitaris* Quiévreux 1965, *L. regaris* (Bailey and Harris 1968), *L. tuberculata* (Bailey and Harris 1968), *L. clava* Harris 1968, and *L. heteropoma* Zibrowius 1968; these 11 species with cross-striations on their collar winged setae. But *L. pacifica* n. sp. without these structure on its collar winged setae.

We can easily distinguish *L. pacifica* from *L. nordenskoildi* (Ehlers 1900) by the number of radioles and the structure of operculum. *L. nordenskoildi* with seven radioles but *L. pacifica* nine.

The third thoracic sickle shaped setae of *L. eximia* (Bush 1904) with dentations in the anterior region only, but in *L. pacifica*, third sickled setae with dentations almost all the geniculate region.

*L. koehleri* Caullery and Mesnil 1897, *L. bernardi* Caullery and Mesnil 1897 and *L. endoumensis* Zibrowius 1968 are very similar species and these differ from *L. pacifica* in the special structures of operculums and talons. These three species have the triangular talon with much compound structures (Caullery and Mesnil 1897, Pl. 10, Figs. 23 and 24, Zibrowius 1968, Pl. 12, Figs. 21–23).

We have still two similar species, namely *L. granulata* (Linnaeus 1767), and

Table 2. Several characters of opercular

Species	Tube	Ten- tacle	Operculum	Collar setae
<i>berkeleyana</i> (Rioja 1942)	D=2-3 mm, loosely coiled, no ridges.	?	Crown-like process, thin long talon.	Winged with distant fin and cross-striation, capillary simple.
<i>berkeleyana</i> in Bailey & Harris 1968	D=1.2-1.7 mm, no ridges.	?	Helmet-shaped.	Winged setae with large teeth.
<i>bernardi</i> Caullery & Mensil 1897	?	?	Multiple plates.	Winged with distant fin and non-cross- striation.
<i>clava</i> (Harris 1968)	D=1 mm, 2 or 3 sharrow ridges.	?	Talon long and spike like.	Winged with distant fin and cross-striation, capillary.
<i>endoumensis</i> Zibrowius 1968	D=1.5-2.4 mm, 3 longitudinal ridges.	9	Cylindrically, short, with broad short talon.	Winged with fin near the blade, capillary.
<i>eximia</i> (Bush 1904)	?	?	Elongated talon with hook like projections.	Winged with fin, blade very wide.
<i>granulata</i> (Linnaeus 1767)	D=1.5-2.5 mm, 3 weak longit- udinal ridges.	?	Cylindrically, long and wide talon.	Winged with distant fin, non-cross-striation.
<i>helenpizelli</i> (Rioja 1942)	D=1-1.3 mm, loosely coiled, no ridges.	?	Crown-shaped with the frill.	Winged with distant fin and cross-striation, capillary simple.
<i>heteropoma</i> Zibrowius 1968	D=1 mm, 2 shallow ridges, central cavity.	?	Rounded plate with one spine.	Winged with distant fin and non-cross- striation, capillary limbate.
<i>koehleri</i> Caullery & Mesnil 1897	D=1.5 mm, few ridges, central cavity.	?	Multiple plate with button-hole.	Winged with distant fin and non-cross- striation.
<i>langerhansi</i> Caullery & Mesnil 1897	Transverse lines, thick, rectan- gular opening.	?	Cone shaped with no talon.	Winged with distant fin and cross-striation.



incubating species of the genus *Laeospira*.

Second setae	Thrid setae	Thoracic uncini	Abdominal		Larval glands	Substratum
			setae	uncini		
Bordered.	Bordered, capillary, sickle.	Rectangular, 40 $\mu$ .	Geniculate, fine serration.	Rectangular, 15 $\mu$ .	?	<i>Spirobranchia incrassatus</i>
Bordered.	Sickle.	40 $\mu$ .	Round teeth.	Thick, 20 $\mu$ .	1	Shell, rock.
?	Sickle.	Left side 45 $\times$ 2 $\mu$ .	?	?	?	Sea-urchin ( <i>Cidaris metularia</i> ).
Bordered.	Bordered, sickle.	Rectangular, 25 $\mu$ , 3 rows of teeth.	Geniculate, dentate.	Thicker than thoracic, 10 $\mu$ .	?	Rock.
Bordered, capillary.	Bordered, capillary, sickle.	Sub-rectangular, 3 rows.	Geniculate, dentate.	Rectangular, thick.	?	Pebble.
Simple limbate.	Sickle.	?	Geniculate, fine serration.	?	?	<i>Serpula</i> tube.
Bordered.	Sickle.	Right 70 $\mu$ $\times$ 4 $\mu$ , left 45 $\times$ 4 $\mu$ .	?	?	?	Bryozoa, others.
Bordered.	Sickle.	Rectangular, 40 $\mu$ .	Geniculate, fine serration.	?	?	<i>Spirobranchia incrassatus</i>
Bordered, capillary.	Bordered, capillary, sickle.	Rectangular, 2 rows.	Geniculate, dentate.	Sub-triangular, thick.	?	Pebble.
?	Sickle.	?	?	?	?	Bryozoa.
?	Bordered, sickle.	?	?	?	?	<i>Callopoma</i> sp. <i>Crucibulum imbricatum</i>

Table 2

Species	Tube	ten- tacle	Operculum	Collar setae
<i>militaris</i> (Claparède 1870)	D=1.5-3 mm, smooth.	9	Many spines into some rows.	Winged with fin near the blade, and cross-striation, capillary dentate.
<i>mörchi</i> (Levinsen 1884)	D=1.2 mm, 2 shallow ridges.	?	Acorn shaped with a top spine.	Winged with distant fin and cross-striation, capillary dentate.
<i>nordenskoildi</i> (Ehlers 1900)	Smooth.	7	Trumpet shaped without talon.	Winged with distant fin and (?) non-cross- striation.
<i>pacifica</i> n. sp.	D=2-2.3 mm, three weak ridges, many growth lines.	9	Trumpet shaped or cylindrical, long and wide talon.	Wingen with distant fin and non-cross- striation, capillary narrow blade.
<i>papillata</i> (Pixell 1913)	D=1.5 mm.	11	Upper edge much papillae.	Winged with distant fin and cross- striation.
<i>pseudomilitaris</i> (Quiévreux 1965)	Longitudinal ridges and growth lines.	7-8	Many short spines on the plate.	Winged with distant fin and cross- striation, capillary.
<i>regalis</i> (Bailey & Harris 1968)	D=2-2.5mm, no ridges.	?	Cylindrically, few spines on the plate.	Winged with distant fin and cross- striation.
<i>sperba</i> (Pillai 1960)	D=2 mm, smooth.	8	Many spines on the plate and on the rim.	Winged with distant fin and non-cross- striation.
<i>tuberculata</i> (Bailey & Harris 1968)	No ridges, many growth lines.	?	Cup-shaped, with small talon.	Winged with distant fin and cross-striation, capillary.

*L. similis* (Bush 1904). *L. similis* now happens to be set the synonym of *L. granulata* (Borg 1917, Bergan 1953, Gee 1964). But *L. similis* differs from *L. granulata* and *L. pacifica* by the form of opercular talon. *L. similis* with the small talon with many grooves on its under side.

Continued

Second setae	Third setae	Thoracic uncini	abdominal		Larval glands	Substratum
			setae	uncini		
Bordered.	Bordered, sickle.	Sub-rectangular, 4 rows, 40 $\mu$ .	Geniculate, dentate.	Sub-triangular, 5-6 rows, 20 $\mu$ .	?	Stone.
Bordered.	Bordered, sickle.	Sub-rectangular, 4 rows, 40 $\mu$ .	Geniculate.	Thick, 20 $\mu$ .	?	Shell, rock, stone.
?	?	?	?	?	?	Rock, algae.
Bordered, simple capillary, basely striation.	Simple capillary, bordered same as 2nd, sickle setae.	Sub-rectangular, left 100 $\mu$ , right 50 $\mu$ .	Geniculate, dentate.	Sub-triangular, thick, 7-8 $\mu$ .	1	Rock.
Sickled with no striation.	Sickle.	?	Geniculate, with long deeply serrated blade.	?	?	Sertularia, shell.
Bordered, capillary.	Bordered, capillary.	?	Geniculate.	?	1	Stone.
Bordered.	Bordered.	Triangular, only one row, 30 $\mu$ .	Geniculate, fine serration.	Same thickness as thoracic, 20 $\mu$ .	1	Rock, shells, serpulid tube, Echinoid test.
Geniculate with serrated blade.		Sub-triangular, 10 $\mu$ .	?	?	?	Oyster shell.
Bordered.	Sickle.	Only one row, 40 $\mu$ .	Geniculate, dentate.	Same thickness as thoracic, 15 $\mu$ .	?	Rock, shell.

*L. pacifica* differs from *L. granulata* by the talon and third thoracic sickle shaped setae. *L. pacifica* with the talon shaped the hoof of Artiodactylan mammals, with a central groove, and with straight and broad teeth dentate of sickle shaped setae in the third thoracic segment. The remarkable characteristics of

*L. pacifica* is to possess the large thoracic uncini on its left side ( $100\mu$ ). The thoracic setae also longer than of *L. granulata* (in Borg 1917, and Gee 1964). Left thoracic uncini of *L. granulata*  $42\mu$  long and right ones  $30-35\mu$  in British specimens by Gee (1964). Right thoracic uncini of *L. pacifica*  $43-47\mu$ .

This species resembles to *L. quadrangularis* in Bush (1904)<sup>1)</sup>, and there are no differences to her simple description and figures, but the figures had no scales and there were no descriptions about the larvae or radioles number.

Table 2 gives the several characters of 19 opercular incubated species belonged to the genus *Laeospira*.

Key to opercular incubating species in genus *Laeospira*.

- |    |  |                           |
|----|--|---------------------------|
| 1  | Tube incubation .....  | 21 species                |
| 1  | Opercular incubation .....   | 2                         |
| 2  | Collar winged setae with cross-striation .....                               | 3                         |
| 2  | Collar winged setae without cross-striation .....                            | 11                        |
| 3  | Without third thoracic sickle-shaped setae .....                             | 4                         |
| 3  | With third thoracic sickle-shaped setae .....                                | 5                         |
| 4  | Fin of collar winged setae with five large teeth only .....                  | <i>L. pseudomilitaris</i> |
| 4  | Fin with two large and six small teeth .....                                 | <i>L. regalis</i>         |
| 5  | Without any structures on the flat upper side of calcareous plate .....      | 6                         |
| 5  | With some structures on the upper side of calcareous plate .....             | 8                         |
| 5  | With rounded calcareous plate .....  | 7                         |
| 6  | Calcareous plate simple cup-shaped .....                                     | <i>L. langerhansii</i>    |
| 6  | Cup-shaped with short talon .....  | <i>L. tuberculata</i>     |
| 6  | Flattened with long spike-like talon .....                                   | <i>L. clava</i>           |
| 7  | Abdominal geniculate setae with a row of teeth at the top of the stalk ..... | <i>L. heteropoma</i>      |
| 7  | Abdominal geniculate setae without such structure .....                      | <i>L. mörchi</i>          |
| 8  | With the spines on the operculum .....                                       | 9                         |
| 8  | With the collar around the operculum .....                                   | 10                        |
| 9  | Spines all the upper plate into many rows .....                              | <i>L. militaris</i>       |
| 9  | Spines on the rim of operculum .....   | <i>L. papillata</i>       |
| 10 | With higher collar part on one side .....                                    | <i>L. berkeleyana</i>     |
| 10 | Without such structure .....   | <i>L. herenpixelli</i>    |
| 11 | With piled calcareous plates in operculum .....                              | 12                        |
| 11 | With simple calcareous plate .....   | 14                        |
| 12 | Talons with one pored stick fixed with neighboring plates .....              | <i>L. koehleri</i>        |
| 12 | Talons without such structure .....  | 13                        |
| 13 | Triangular talons large .....  | <i>L. bernardi</i>        |

1) *L. quadrangularis* in Bush (1904) was the redescription of Moore (1902) from Greenland. Pixell (1912) agreed with her description, but *L. quadrangularis* (Stimpson 1854) was arranged to the synonym of *L. granulata*, and Bush's description seems to differ from the species by Stimpson 1854.

13	Triangular talons small	<i>L. endoumensis</i>
14	With no talon	<i>L. nordenskoildi</i>
14	With talon	15
15	Talon broad, triangular with many short projections	<i>L. eximia</i>
15	Talon small with many grooves	<i>L. similis</i>
15	Talon semi-rhombic	16
16	Left thoracic uncini large	<i>L. pacifica</i>
16	Left thoracic uncini small	<i>L. granulata</i>

The following tables illustrate the distributions of setae and uncini on each segment of the four new species described here. The types of setae are denoted by the column heading as follows: Wgd. — winged setae, Cap. — capillary setae, Bdd. — bordered setae, Skl. — sickle setae, Unc. — uncini, and Gen. — geniculate abdominal setae. The numbers in parentheses refer to length of thoracic uncini in micra.

Table 3. *Paradexiospira nakamurai* sp. nov.

	Seg.	Left					Right				
		Wgd.	Cap.	Bdd.	Skl.	Unc.	Wgd.	Cap.	Bdd.	Skl.	Unc.
Thorax	1	10	10	—	—	—	8	8	—	—	—
	2	—	12	12	—	32(29)	—	12	12	—	58(43)
	3	—	12	—	10	25(28)	—	11	—	10	71(45)
	4	—	—	—	—	—	—	—	—	—	67(42)
		Gen.		Unc.		Gen.		Unc.			
Abdomen	1	1		—		—		14			
	2	3		—		—		23			
	3	3		—		2		31			
	4	1		—		2		34			
	5	1		—		1		37			
	6	1		—		1		34			
	7	1		—		2		32			
	8	2		—		1		12			
	9	1		—		1		26			
	10	2		—		2		40			
	11	2		—		1		37			
	12	2		—		1		31			
	13	2		—		2		27			
	14	1		—		1		21			
	15	1		—		1		20			
	16	1		—		1		19			
	17	1		—		1		15			
	18	2		1		1		13			
	19	1		4		1		12			

20	1	5	1	15
21	1	2	1	12
22	2	3	1	12
23	2	3	1	13
24	1	5	1	11
25	1	4	1	13
26	1	4	1	11
27	1	2	1	13
28	1	4	1	11
29	1	5	1	10
30	1	6	1	10
31	1	5	1	10
32	1	6	1	9
33	1	7	1	9
34	1	8	1	7
35	1	4	1	6
36	1	8	1	7
37	1	7	1	7
38	1	7	1	7
39	1	5	1	5

Table 4. *Paradexiospira nakamurai* sp. nov.

	Seg.	Left					Right				
		Wgd.	Cap.	Bdd.	Skl.	Unc.	Wgd.	Cap.	Bdd.	Skl.	Unc.
Thorax	1	10	10	—	—	—	8	8	—	—	—
	2	—	14	14	—	33	—	14	14	—	86
	3	—	14	—	14	26	—	12	—	12	94
	4	—	—	—	—	—	—	—	—	—	89
		Gen.		Unc.			Gen.		Unc.		
Abdomen	1	—		—			—		21		
	2	—		—			—		46		
	3	3		—			2		50		
	4	2		—			2		49		
	5	2		—			2		45		
	6	2		—			3		36		
	7	2		—			3		40		
	8	2		—			2		32		
	9	2		—			2		39		
	10	2		—			1		42		
	11	1		—			2		39		
	12	2		—			2		36		
	13	2		—			1		32		
	14	2		—			2		23		
	15	2		—			3		17		
	16	1		—			2		14		
	17	2		—			1		15		
	18	2		—			2		14		
	19	1		—			2		11		

20	1	—	2	12
21	2	—	1	12
22	2	—	1	11
23	1	—	1	12
24	1	—	1	13
25	2	—	1	10
26	1	—	1	13
27	2	—	1	9
28	1	—	2	10
29	2	—	1	10
30	1	—	1	12
31	1	3	2	9
32	1	5	1	8
33	1	4	1	8
34	2	3	1	9
35	2	5	1	7
36	2	4	1	7
37	1	4	1	9
38	2	3	2	7
39	1	3	1	7
40	1	3	2	7
41	2	3	1	5
42	1	3	2	4

Table 5. *Dexiospira oshoroensis* sp. nov.

	Seg.	Left					Right				
		Wgd.	Cap.	Bdd.	Skl.	Unc.	Wgd.	Cap.	Bdd.	Skl.	Unc.
Thorax	1	6	6	—	—	—	6	6	—	—	—
	2	—	8	13	—	16(26)	—	8	13	—	30(34)
	3	—	6	11	—	34(24)	—	6	11	—	36(35)
		Gen.		Unc.			Gen.		Unc.		
Abdomen	1	—		9			1		—		
	2	1		12			1		—		
	3	1		10			1		—		
	4	2		9			1		12		
	5	2		5			1		10		
	6	1		4			1		5		
	7	1		4			1		4		
	8	1		3			1		4		
	9	1		2			1		4		
	10	1		—			1		2		

Table 6. *Dexiospira oshoroensis* sp. nov.

	Seg.	Left					Right				
		Wgd.	Cap.	Bdd.	Skl.	Unc.	Wgd.	Cap.	Bdd.	Skl.	Unc.
Thorax	1	6	6	—	—	—	6	5	—	—	—
	2	—	6	11	—	15	—	6	9	—	28
	3	—	7	8	—	36	—	5	5	—	36
		Gen.		Unc.			Gen.		Unic.		
Abdomen	1	—		—			1		—		
	2	1		12			1		—		
	3	1		15			1		13		
	4	1		13			1		13		
	5	1		16			1		4		
	6	1		9			1		6		
	7	1		?			1		5		
	8	1		5			1		6		
	9	1		6			1		4		
	10	1		6			1		1		
	11	1		4			1		—		
	12	—		1			1		—		

Table 7. *Dexiospira ainu* sp. nov.

	Seg.	Left					Right				
		Wgd.	Cap.	Bdd.	Skl.	Unc.	Wgd.	Cap.	Bdd.	Skl.	Unc.
Thorax	1	6	6	—	—	—	6	6	—	—	—
	2	—	8	9	—	20 (26)	—	8	9	—	37 (34)
	3	—	6	10	—	36 (24)	—	6	8	—	50 (35)
		Gen.		Unic.			Gen.		Unic.		
Abdomen	1	1		—			—		18		
	2	1		16			1		15		
	3	1		15			1		17		
	4	1		8			1		12		
	5	1		5			1		6		
	6	1		5			1		6		
	7	1		5			1		6		
	8	2		7			1		5		
	9	1		5			1		4		
	10	2		2			1		3		
	11	1		—			2		—		



Table 8. *Dexiospira ainu* sp. nov.

	Seg.	Left					Right				
		Wgd.	Cap.	Bdd.	Skl.	Unc.	Wgd.	Cap.	Bdd.	Skl.	Unc.
Thorax	1	6	6	—	—	—	6	6	—	—	—
	2	—	8	9	—	18	—	8	9	—	36
	3	—	6	10	—	31	—	6	8	—	?
		Gen.		Unc.			Gen.		Unc.		
Abdomen	1	1		—			—		15		
	2	1		14			1		13		
	3	1		11			1		13		
	4	1		8			1		10		
	5	1		6			1		6		
	6	2		6			2		6		
	7	2		5			1		6		
	8	1		4			1		5		
	9	1		3			2		3		
	10	1		—			1		1		
	11	1		—			1		—		

Table 9. *Laeospira pacifica* sp. nov.

	Seg.	Left					Right				
		Wgd.	Cap.	Bdd.	Skl.	Unc.	Wgd.	Cap.	Bdd.	Skl.	Unc.
Thorax	1	10	8	—	—	—	8	8	—	—	—
	2	—	7	14	—	108(100)	—	7	14	—	36(37)
	3	—	9	9	10	100(100)	—	9	9	10	60(38)
		Gen.		Unc.			Gen.		Unc.		
Abdomen	1	—		3			1+1		6		
	2	—		35			1+1		6		
	3	—		56			3+1		?		
	4	1+1 <sup>1)</sup>		24			3+1		?		
	5	2+1		39			3+1		34		
	6	3+1		39			2+1		29		
	7	3+1		36			2+1		26		
	8	5+1		32			2+1		32		
	9	3+1		34			2+1		27		
	10	2+1		34			2+1		30		
	11	2+1		28			2+1		24		
	12	2+1		26			2+1		16		
	13	2+1		27			2+1		22		
	14	2+1		27			2+1		20		
	15	2+1		28			2+1		15		
	16	2+1		24			2+1		17		
	17	2+1		17			1+1		12		
	18	1+1		18			1+1		10		

19	1+1	15	1+1	10
20	1+1	14	1+1	11
21	1+1	9	1+1	8
22	1+1	10	1+1	9
23	— 1	12	1+1	5
24	— 1	9	1+1	5
25	—	—	1+1	3

1) Formulae of abdominal setae illustrate the geniculate dentate setae in the former and smooth setae (Fig. 8-N) in the latter.

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